Can the hypothesis 'photon interferes only with itself' be reconciled with superposition of light from multiple beams or sources?

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Abstract

Any superposition effect as measured (SEM) by us is the summation of simultaneous stimulations experienced by a detector due to the presence of multiple copies of a detectee each carrying different values of the same parameter. We discus the cases with light beams carrying same frequency for both diffraction and multiple beam Fabry-Perot interferometer and also a case where the two superposed light beams carry different frequencies. Our key argument is that if light really consists of indivisible elementary particle, photon, then it cannot by itself create superposition effect since the state vector of an elementary particle cannot carry more than one values of any parameter at the same time. Fortunately, semiclassical model explains all light induced interactions using quantized atoms and classical EM wave packet. Classical physics, with its deeper commitment to Reality Ontology, was better prepared to nurture the emergence of Quantum Mechanics and still can provide guidance to explore nature deeper if we pay careful attention to successful classical formulations like Huygens-Fresnel diffraction integral.

[Key Words: Superposition effects, Reality Ontology, single photon interference, Huygens-Fresnel principle, Bell's inequality]

1. Classical physics nurtured the emergence of quantum physics by underscoring Reality Ontology

Maxwell presented his comprehensive equations on electromagnetism in 1864 by synthesizing the rules of electricity and magnetism developed by Coulomb, Ampere, Gauss and Faraday, all of whom lived between 1736 and 1867. Lorentz utilized this knowledge to correctly attribute the generation of light by atoms as due to dipole like undulations of electrons in atoms validated by observation of Zeeman effect in 1896 in which magnetic field splits the spectral lines. This dipole model with multiple absorption lines led to the development of a quite accurate model of dispersion theory with distinct "oscillator strengths" for the different absorption lines, which was corroborated many decades later after quantum theory was fully developed.

Before the end of 19th century, Rydberg-Ritz formula:

$$\nu = cR_y\left(\frac{1}{n^2}-\frac{1}{m^2}\right) \tag{1}$$

was correctly mapping the discrete spectroscopic frequencies found from gas discharge lamps, where R_y is the Rydberg constant and $n\,\&\,m$ are integers that turned out to be the "principal quantum numbers" by both Bohr's early heuristic quantum theory and later formal Quantum Mechanics. By 1900 Planck also captured another very important quantum nature of light regarding its emission and absorption through his heuristic representation of the classical experimental energy density curve for "blackbody" radiation:

$$u(\nu,T)=\frac{8\pi h\nu^3}{c^3}\frac{1}{\exp(h\nu/kT)-1} \tag{2}$$

Some 25 years later, quantum theory did find that individual atomic transitions do correspond to quantized energy exchange of $\Delta E_{mn} = h\nu_{mn}$, establishing the logical congruence between the Eqns.1 and 2. Noteworthy also was the derivation of "A and B coefficients" by Einstein for stimulated absorption and emission from atoms, which gave birth to lasers much later during 1960's. By 1924, before the advent of formal quantum mechanics, Bose-Einstein statistics was published yielding a number of Nobel Prize winning works awarded only recently.

Our point in summarizing these elementary classical achievements of various observed phenomena is to underscore that the platform for the birth of Quantum Mechanics (QM) and the necessary structure for formulating it were already embedded in classical physics. *Classical physics, by staying focused on how to figure out the actual processes behind various interactions in nature, succeeded in nurturing the minds of the scientists for the next revolutionary change in understanding nature*. In contrast, QM, due to its rapid successes beyond expectations in computing the observable results with extreme accuracy, marginalized and even opposed seeking reality in the micro world. It proactively taught us not to waste our energy in imagining and visualizing the actual processes going on in nature. Even after more than 80 years of maturity, QM has failed in its leadership role to facilitate the next revolution in constructing new concepts to map processes of the micro world with further depth. We believe that this has been due to the belief system established by some of the key founders and developers of QM. For generations, we have been systematically pushed to believe that: (i) QM is a *complete* theory of the micro world; (ii) visualizing the actual processes in the micro world is beyond QM and hence human imaginations; (iii) the "lack of knowledge" as to which way light or particle beams travel to the detector is essential to the emergence of interference patterns, etc. Heisenberg's indeterminacy relation for measurements [1], essentially a corollary of the Fourier theorem, has been re-interpreted as incessant violation of causality in the micro world. This is inspite of our general agreement in the scientific culture that all organized bodies of knowledge in use to day are necessarily provisional and incomplete because they have been constructed based on the incomplete knowledge of the universe. Our enquiring mind is now trained to ask only those questions which are congruent within the logical bounds of the accepted theories, effectively ensuring that we will never find our way out beyond the current framework of QM. We have essentially abandoned exploring reality of nature by spending most of our time in abstract N-dimensional spaces leaving our body behind in the intellectually contemptible 3D space!

All the startup classical physics rules ("laws") were firmly rooted on Reality Ontology (RO). The mathematical relationships were such that all the symbols represented some dynamic and/or static parameter of the state of a physical entity and the operators implied some actual interaction (force law) or evolving process constrained by some conservation rule. Unfortunately, rapidly accelerating successes of the mathematical QM formalism and the concomitant exuberance diverted us from keeping ourselves anchored to Reality Ontology. We misplaced our objective of doing science as figuring out the actual processes behind all the magnificent cosmic evolutionary events to become mere data gatherers and data correlators. We have become equation-crunchers as computers are our number crunchers. By demeaning our visualization and imagination faculties, we have made our enquiring mind subservient to a belief system that elegance, esthetic beauty and symmetry of mathematical relationships give us the power over nature and tell her how she ought to behave in carrying out physical processes. We need to take special note that we can experience nature only through various interaction processes. Accordingly, we are better off by visualizing nature as a creative system engineer. Therefore, we should humbly act as reverse-engineers to explore and emulate the natural processes that will lead us to better understand the purpose of the cosmic evolution and then figure out our proper place within the biosphere and then the cosmic system. For generations students have been trained to "crank the equations" instead of nurturing their inquiring minds. If "nobody understands quantum mechanics", we ought to urge the students with proactive encouragements that there must be something seriously wrong with the interpretations of QM.

2. Building bridges with logically congruent conceptual continuity by identifying neglected "details"

We know that the commutators, daggers, bras and kets enclosing various letters to represent specific states of natural entities have been doing wonders that we can still take great pride about after more than 80 years of successes. However, we have been neglecting too many "details" in our formulations, computations and interpretations. First, a state vector in QM does not possess the capability to carry multiple parametric values for the same parameter of the same stable identifiable entity at the same time. We also have ample reason to firmly believe in the Superposition Principle (SP), which is the superposition

of two or more distinctly different values of the same parameter for a particular type of entity. These different values for the same "quality" (parameter) cannot be carried by the same entity. If elementary particles and atoms were really multi-valued at the same time, we would have never been able to develop any logical theories that could give validate-able results all the time. Yet, we would rather stick to the concept of "single photon interference" than exploring the deeper aspects or the processes that give rise to the "superposition effects as measured" (SEM) [2-4].

We should recognize that in the real world, an optical beam can be produced only as a space and time finite EM wave packet, conceding at this moment that this wave packet may be composed of innumerable elementary particles, we have named photons. All real world instrument designs are based on propagating these EM wave packets using mathematically enhanced Huygens-Fresnel Principle [5, 3]:

$$U(P_0) = \frac{-i}{\lambda}\iint_{\Sigma} U(P_1)\frac{\exp(ikr_{01})}{r_{01}}\cos\theta\, ds \tag{3}$$

Rigorously speaking, $U(P_0,t) = \frac{-i\nu}{c}\iint_{\Sigma} U(P_1,t)\frac{\exp(i2\pi\nu t)}{r_{01}}\cos\theta\, ds;\;\; t=(r_{01}/c)$ (4)

There are enormous amount of "little details" that the engineers must take into account to make instrument work. There are an infinite number of secondary spherical wavelets that re "generated" by $U(P_1,t)$ on the diffracting aperture Σ, the effects of which must be superposed (summed) at the observation point $U(P_0,t)$. In the real world, Eq.4 underscores that all interference and diffraction patterns evolve with time. When the input signal $U(P_1,t)$ is very long and we finish our measurements for sure within an interval when its amplitude is steady, we can "get by" with the steady state Eq.3. How do we establish conceptual continuity in photo counting experiments when $U(P_0,t)$ must be computed from Eq.4?

Cosine fringes due to Young's double slit have become the iconic support to promote the "mystery" of QM. First, we can comfortably accept the reality that the steady state case represented by Eq.3 can be simulated in the laboratory. Then, for the one dimensional case of double slit at the "far field" we will have an intensity pattern is:

$$I(x) = |U(P_0)|^2 = \frac{A^2}{\lambda^2 z^2}\operatorname{sinc}^2\left(\frac{2\pi a x}{\lambda z}\right)\cos^2\left(\frac{2\pi b x}{\lambda z}\right) \tag{5}$$

Where x is the observation plane at a distance z and 2a is the width of each slit and 2b is the spacing of the slits; A is a constant. To obtain the value of $I(x)$ at any point x requires taking the square modulus of the sum of infinite number of complex amplitudes due to H-F secondary wavelets. Can a single photon manage to pick up all these information and all these computations to decide exactly where and at what density to arrive at the observation plane? Our reliance on causality will come into even more serious question when our input wave front $U(P_1,t)$ is time varying. If Eq.3 and 4 works in the real world, we should spend serious time accepting that these equations contain more physics than QM formalism is capable of exploring. This is because the QM operators ignore every details of HF integral and assume the bare-bone two far field ("plane wave") state phases $\exp[\pm i2\pi bx/\lambda z]$ corresponding to the same photon and the square modulus gives the desired result:

$$I_{QM}(x) = \left|e^{i2\pi bx/\lambda z} + e^{-i2\pi bx/\lambda z}\right|^2 = 4\cos^2\left(\frac{2\pi b x}{\lambda z}\right) \tag{6}$$

The neglected "little details" about the sinc^2 envelope contain an infinite number of physical parametric values that gives rise to the correct observation of Eq.5, which cannot be carried by a single indivisible photon. Also note that the total relative phase delay between the two signals from the two slits at any of the observation point x has a differential time delay of $\delta t = (2xb/z)/c$. Since the origin of the phase delay is really due to differential path delays and the velocity of light is fixed to c, the concept for "single photon interference" is also demanding superluminal velocity for light. Note that

The realities of diffraction phenomenon buried in the neglected "details" captured by HF integral can be further appreciated by setting up two narrow slits and then registering the patterns continuously from the very near field (close to the aperture) to the very far filed. Fig.1 shows the computation for the case of two

5-micron slits set at 20-micron spacing. Propagation of light beams is inherently diffractive because they are undulations of some all pervading tension field, which is otherwise always in a state of equilibrium [3]. Consider how waves on water surface propagate and diffracts leveraging the existing surface tension force holding the water surface everywhere in equilibrium.

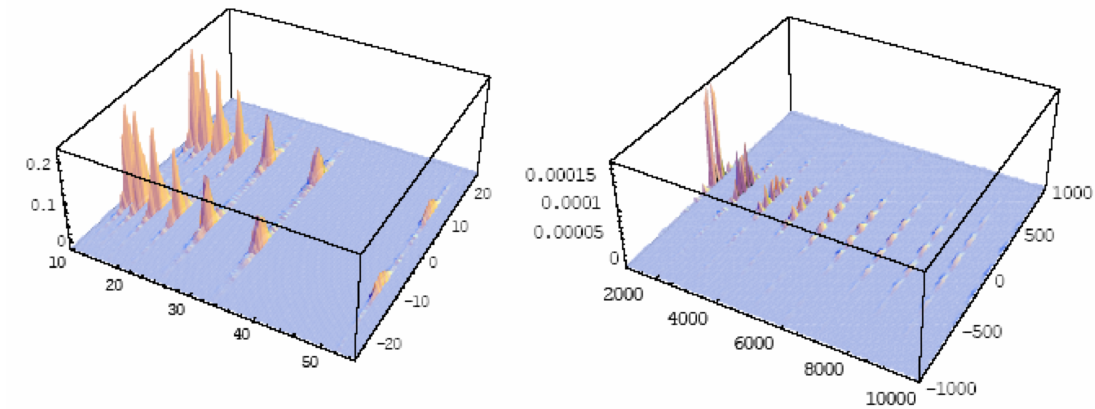

Figure 1. Evolving diffraction patterns in the near-field and the far-field domains due to a pair of slits of 5 microns width and 20 microns spacing. In the near-field domain one can record two independent sinc^2-like intensity patterns due to each slit. As they diffractively evolve by spreading laterally, they start slowly overlapping creating quite complex and evolving double-slit patterns that we conveniently ignore. Eventually in the far filed when the real physical overlap of the two sinc^2 diffraction patterns becomes complete, then only we can record perfect $\cos^2$ fringes under the sinc^2 envelope.

Looking for logically congruent conceptual continuity among the neglected "details" behind the otherwise very successful HF integral helps us to conceive that the space could really be a rich medium holding all pervading tension filed to allow the generation and diffractive propagation of EM waves. Fortunately, semiclassical model for superposition effects [6, 7] preserves the causality without the need of "indivisible photons" simply by accepting classical EM waves as divisible and diffracting and detecting atoms as quantized. As far as the "tension field" is concerned [3, 8], let us underscore that every successful theory that we have so far developed, from classical to string theories, accept the existence of fields in some form or other. Obviously, this "tension field" cannot be "material' based like the "ether theory" of 19^{th} century.

In diffraction, once the far-field pattern reaches its asymptotic state, its angular shape becomes constant during all further propagation, albeit suffering from slow spatial (lateral) divergence. In other words, EM wave packets, once generated by a source or perturbed by some aperture, they tend to evolve into an angularly stable asymptotic shape that is maintained during any further propagation. If we extend this concept into the time domain for an arbitrary shaped time finite light pulse, we musty accept its temporal evolution, even in dispersion-free vacuum, according to Eq.4 into an asymptotically stable pattern in the longitudinal direction (temporal shape of the pulse) in the far field constrained by the joint dependence of the HF wavelets on both the space and time coordinates. The time-frequency Fourier transform of the input pulse $U(P_1, t)$ cannot be inserted in Eq.4 to separate the space and time variables under the most general situation. The "coherent" Fourier monochromatic components, existing in all space and time, are non-causal and hence will produce non-causal predictions. This has also created confused notion for how to measure the spectrum and dispersion of a pulsed light [9-13]. It is important to note the dialectical nature of light. If perturbed, the "broken up" wave fronts collectively re-shape themselves into a new cohesive asymptotically stable beam, and yet when such "stable" beams propagate through each other, they remain unperturbed unless interacting material dipoles happen to be in the physical volume of superposition [4]. This last point of the need for the presence of detector to register the superposition effects will be illustrated in the next section while underscoring again that superposition by definition requires multiple physical entities that can successfully carry different information to maintain causality intact in the detection processes.

3. Superposition is a multiple value multiple entity interaction process

We have already underscored that that QM formalism does not accept that the state vector representing a particular parameter of a quantum entity can assume multiple values at the same moment. Consider the superposition fringe pattern that we register by using a Fabry-Perot interferometer (FPI) consisting of two parallel splitters separated by d cm with reflectance R and transmittance T, with $\tau = 2d / c$. The value of τ could be quite large, 10ns for a 150cm FPI:

$$I_{cw}(\nu,\tau) = \left| \sum_{n=0}^{\infty} TR^n e^{i2\pi\nu\tau} \right|^2 = T^2 / [(1-R)^2 + 4R\sin^2 \pi\nu\tau] \tag{7}$$

The summation contains an infinite number of information on two distinctly different parameters of light wave or "photons" – the amplitude of the E-vectors TR^n and its temporal undulating phase $\exp[i2\pi\nu\tau]$ on arrival at the detector following the FPI. When the reduced intensity light beam contains only one indivisible photon at a time, then how does such a single elementary particle manage to keep track of n-amplitude and n-phase information with n-number of τ intervals? The situation gets even more confusing when the input signal is time finite $a(t)\exp[i2\pi\nu t]$, as is always the case in the real world since even a CW laser needs to be turned on and turned off [Fig.2]. In that case we have another time

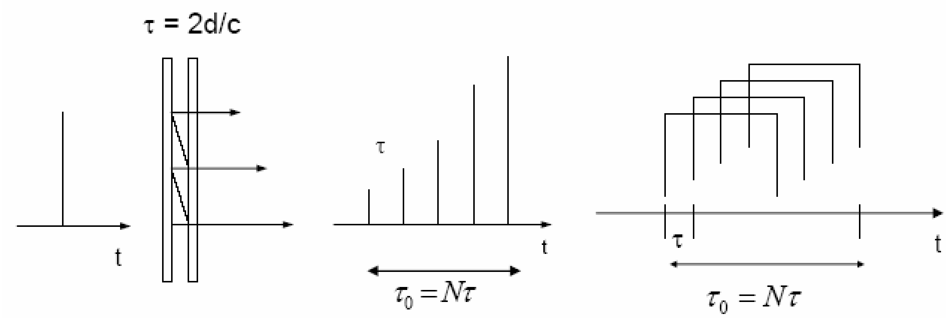

Figure 2. The above figure underscores that ultra short pulses narrower than the round trip delay τ can only produce a train decaying pulse train which is exploited in CRDS spectroscopy; they are never superposed and hence cannot produce any "interference" effects. Pulses wider than τ give time evolving superposition effects. Only pulses longer than $\tau_0 = N\tau$ will generate, under long time integration, superposition effects that can be represented by the classical text book-like expression of Eq.7.

varying parameter $a(t-n\tau)$ that multiplies the variable parameter TR^n. Now FPI intensity evolves with time (Eq.8) that does not have an elegant solution like Eq.7 [14, 15]. Again, if we reduce the intensity to the level of a single photon at a time, we are puzzled by the following question. How does a single photon keep track of the time varying density of other photons before and after it in the pulse?

$$E_{pls}(\nu,\tau) = \left| \sum_{n=0}^{\infty} TR^n a(t-n\tau) e^{i2\pi\nu(t-n\tau)} \right|^2 \tag{8}$$

If the fringes are recorded over a very long period by a photographic plate, the time integrated fringe pattern will be given by Eq.9 that is broader than that due to Eq.7:

$$I_{pls}(\nu,\tau) = \sum_{n=0}^{N-1} T^2 R^{2n} + 2\sum_{n\neq m}^{N-1} T^2 R^{n+m} \gamma(|n-m|\tau)\cos[2\pi(n-m)\nu\tau] \tag{9}$$

$$\text{Where, } \gamma(p\tau) \equiv \gamma_{nm}(\tau) \equiv \gamma(|n-m|\tau) = \frac{\int a(t-n\tau)a(t-m\tau)\, dt}{\int a^2(t)\, dt} \tag{10}$$

Thus, demanding photons to be indivisible elementary particles, we are forced to impose on it that it can modulate its behavior as if it can simultaneously posses an infinite number of parametric values even though such parametric values needs to be generated over a long period at intervals of τ. In classical physics, the problem is trivially solved by assuming that the incident wave front reverberates within the FPI to generate a long train of wave fronts with a periodic delay τ and helps a detector to choose to respond to such a complex, evolving wave train in time [14]. The recorded pattern can be time-evolving or stationary depending upon the duration of the incident wave packet. The root of the problem started with classical

physics and we have unwittingly carried that into QM physics. Well formed light beams do not interfere with each other [17, 4] in the absence of interacting material dipoles. The light beams simply pass through each other unperturbed unless we insert a detector or a dielectric boundary with right conditions within the physical volume of superposition. In reality, the dipoles carry out the summation of all the stimulations induced by all the E-vectors carrying all the discrete amplitude TR^n and time delayed phase $\exp[i2\pi\nu\tau]$ information and respond accordingly. We can only measure the square modulus of these joint dipole stimulations, provided all the E-vector fields were simultaneously present on the interacting dipoles. Thus, from the standpoint of mapping actual processes, the Eqns.8, 9 and 10 are incomplete. They are devoid of a crucial physics parameter, the linear susceptibility ${}^{(1)}\chi$ for the dipoles to the polarizing stimulation. For example, Eq.8 should re-write as:

$$D_{cw}(\nu,\tau) = \left|\sum_{n=0}^{\infty} d_n(\nu,\tau)\right|^2 = \left|\sum_{n=0}^{\infty} {}^{(1)}\chi T R^n e^{i2\pi\nu\tau}\right|^2 = {}^{(1)}\chi^2 T^2 \big/ [(1-R)^2 + 4R\sin^2 \pi\nu\tau] \quad (11)$$

Where $d_n(\nu,\tau)$ represents the dipole stimulation due to the n-th E-vector, $D_{cw}(\nu,\tau)$ being the total photo current proportional to the output light intensity. The physical dipolar properties that limit the simultaneous response capabilities of the dipoles are buried into ${}^{(1)}\chi$, like multiple polarization and/or multiple Poynting vectors, etc., which will be discussed later. The Eq.11 represents Reality Ontology but the Eq.8 does not. The difference being only a constant, we can ignore it for theoretical purposes, but then we do not teach physics.

4. Heterodyne experiments

For most interference experiments with CW light beams of same frequency, the fringes are generally time-stationary (ergodic) and the "time of arrival of photons" at very low rate of photo electron count can be easily hidden behind the photo electron emission statistics. This section focuses on utilizing the superposition-effect-induced periodic emission of electrons to convince the readers that "photon interferes only with itself" [16] is an unnecessary and restrictive statement in light of modern experimental understanding. Consider the simple experimental set up of Fig.3 where two CW lasers with frequencies ν_1 and ν_2 have been combined as collimated and collinearly superposed beams on a high speed heterodyne detector connected to an oscilloscope. The heterodyne current is given by the square modulus of the sum of the two simultaneously induced dipolar stimulations:

$$\begin{aligned} &E_{1,2}(t,\nu_{1,2}) = a\exp[i2\pi\nu_{1,2}t] \\ &D(t,\nu_1-\nu_2) = {}^{(1)}\chi^2 a^2 \left|\mathrm{e}^{i2\pi\nu_1 t} + \mathrm{e}^{i2\pi\nu_2 t}\right|^2 = 2\,{}^{(1)}\chi^2 a^2[1+\cos 2\pi(\nu_1-\nu_2)t] \end{aligned} \quad (12)$$

We now have a sinusoidal current with a periodicity of $\tau_{Het.} = 1/(\nu_1-\nu_2)$. The amplitude of this sinusoidal current can be controlled by an intensity controlling device A. If we now interpret the temporal fringes (detector current) of Eq.12 as due to arrival and non arrival of photons from the two independent and yet "indistinguishable" sources (the key to quantum interference!) on the heterodyne detector, then we will be forced to conclude that the insertion of the beam combining beam splitter BS3 forces the two CW lasers to become two perfectly modulated lasers with a modulation frequency:

$$\delta\nu = (\nu_1-\nu_2) = 1/\tau_{Het.} \quad (13)$$

Could we exploit this "quantum interference property" by photons as a technique to create perfectly mode-locked laser at any desirable difference frequency? Obviously, it would not work. We can verify the situation by inserting two more fast detectors with two more beam splitters to test whether the two lasers start oscillating whenever BS3 is in place. We firmly believe that the currents will be CW irrespective of whether the BS3 and/or the heterodyne detector are in place or not. That the measured superposition effect is totally local and is only a response of the heterodyne detector to the simultaneous presence of the two EM waves can be appreciated in several ways.

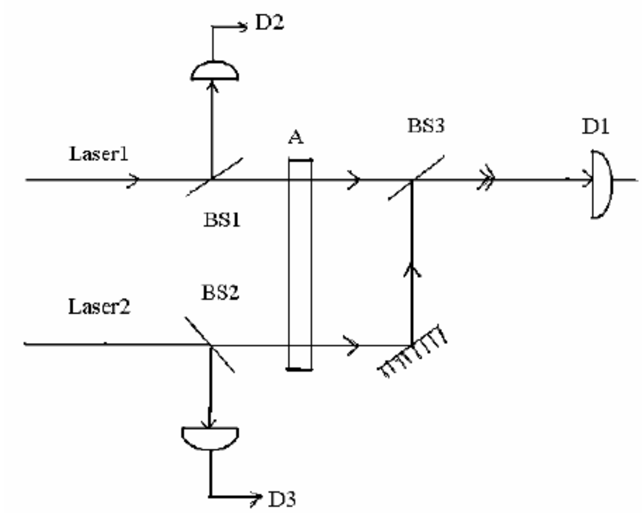

Figure 3. A proposed heterodyne experiment for mixing two independent lasers with two different frequencies on a fast detector. The fast detector will generate a current at the difference frequency. If it were true that "photon interferes only with itself", then external mixing of the two beams must start modulating the original CW lasers at the heterodyne difference frequency, which is absurd!

First, let us eliminate the possibility that BS3 is not introducing the temporal modulation of the light. This we know from the success of Michelson's Fourier Transform Spectrometry (FTS). It is based on the correct assumption that different optical frequency light beams are effectively "incoherent" on a passive beam splitter. A passive beam splitter does not influence the relative intensities of beams corresponding to different frequencies when they are being combined by it [12].

Second, we can introduce another parametric variation on BS3 by changing it from 50/50 to some different value. Suppose the two combined and collinear beams come out with amplitudes a_1 and a_2. The corresponding temporal heterodyne fringes (detector current) will have visibility reduced by a factor γ :

$$D_{HSD}(t,\delta\nu) = {}_{(1)}\chi^2 \left| a_1 \,\mathrm{e}^{i2\pi\nu_1 t} + a_2 \,\mathrm{e}^{i2\pi\nu_2 t} \right|^2 = {}_{(1)}\chi^2 (a_1^2 + a_2^2)[1+\gamma\cos 2\pi\delta\nu t] \qquad (14)$$
$$\gamma = 2a_1 a_2 /(a_1^2 + a_2^2)$$

To comply with the hypothesis "photon interferes only with itself", we now must hypothesize that two lasers somehow receives feed back from BS3 (that it is no longer 50/50) and hence controls the total number of photon arrival still undulating at the same difference frequency $\delta\nu$ (Eq.13), but now there is a "DC" bias, or a steady stream of photons besides the undulation in their number. As before, we believe that the two detectors that directly measure the two laser powers will show CW current.

5. Summary and Discussions

Semiclassical treatment [6, 7] provides adequate mathematical support for most photo induced interactions. Consequently, it is counter productive to create wide ranges of non-causal, non-local hypotheses to accommodate Dirac's statement, "photon interferes only with itself", which appeared perhaps logical in 1930. By definition, superposition effect is the summation of simultaneous stimulations experienced by a detector due to the presence of multiple copies of a detectee each carrying different values of the same parameter. Since the state vector of an elementary particle cannot carry different values of the same parameter at the same time, we should use semiclassical model to explore deeper into the physical processes that are going on during all light-matter interactions.

Nature is profoundly logical. That is the key reason behind our successes in understanding so much about the processes behind the evolving unified universe from atoms to single living cells to galaxies and their collectives. We also know that we do not know so many things about how this universe functions as unified system. Mathematics is the best logical tool that we have invented to explore nature. It gives us the capability to frame a functioning logical system guided by our concepts (imaginations, visualizations)

corroborated by observations. But here comes the dialectical dilemma. A mathematical equation to work, it must be a logically self contained or closed system for it to be able to reproduce observed results. But once it has been closed with self consistent and congruent logic, like a solved puzzle it cannot accommodate totally new set of logic within it. Observation based assumptions that go behind structuring the equation are necessarily incomplete since we do not yet know the details behind its complete connection with the rest of the universe. Generally we call it reasonable "local" approximations. While this is the only way we can start our advancement from ignorance towards successive states of enlightenment, this is also the key point where our imaginations, however logically self consistent they may be, can introduce some Human Logic (locally correct) to make the equation predict the observations but this Human Logic may or may not be extendable to the true Cosmic Logic necessary for a future unified theory as we evolve forward. We tend to take care of this problem by accepting a formulation as an acceptable theory by imposing the metric that the theory must predict new things and new behaviors of nature that we did not know or understood before. When an equation is correctly predicting previously unknown things, obviously it must have captured some Cosmic Logic in it. But how do we separate out the logically consistent yet untenable Human Logic components in the theory that need to be dropped before it could be advanced to accommodate more Cosmic Logic? Transition from classical electromagnetism to quantum theory is an excellent example. But have we learned to quantify the number of necessary successes and the type of failures that will allow us to seriously question which of the Quantum Logics are potential Cosmic Logic and which ones are non-extendable Human Logics and must be discarded?

Today we have over half a dozen or more "solved puzzles" or theories that are logically congruent and self consistent in mapping the behavior of different domains of nature: (i) classical theory, (ii) special relativity, (iii) general relativity, (iv) quantum mechanics, (v) quantum field theory, (vi0 cosmology (vii) string theory, etc. We need to develop organized research efforts and the necessary epistemology to sort out the Cosmic Logic and the Human Logic out of all these theories. If we treat them as all "Sermon on the Mount" we will never succeed advancing science very much further or finding any unified theory of for cosmic evolving cosmic system. Almost fifty years of failure to find anything fundamentally new clearly tells us that we need to reassess all the hypotheses that are behind all these different "successful" theories.

Focus of classical physics has been to figure out the reality, the actual processes behind the natural events we study. The approach has paid off by nurturing the evolution of many more theories. Unfortunately, a number of the new theories have explicitly abandoned seeking reality as an intellectually demeaning endeavor. But they have failed to either find new significant knowledge out of nature or give birth to new significant theories, which could do that. We have trapped ourselves into justifying why QM is complete. This is albeit of our knowing that any and all organized bodies of human knowledge system in use are only provisional and incomplete for they have been organized based on our incomplete knowledge of the universe.

Consider the Eqns. 1& 2 on Rydberg and Planck relations. Measurable parameters are connected by nature's constants (containing deeper processes in nature) with the various physical parameters of the entity (system) we are observing. Some of these parameters represent primary physical parameter directly relating to the physical behavior of the observed entity and the others are secondary parameters we require to close the logical loop that may also change. A simple example is $\nu = c/\lambda$. The frequency is an unchanging key physical parameter while the wavelength varies from medium to medium along with c. The Eqns. 3 to 10 representing superposition effects of light waves under various conditions has some serious flaw. We never "see" light except through the "eyes" of various detectors and EM waves do not really interact with each other to make themselves visible to us. In this paper, we have taken care of the problem in Eqns. 11, 12, 14 by explicitly inserting the susceptibility χ of the detector dipole, which is well recognized in both classical and quantum physics and yet we benignly neglect most of the time creating the erroneous impression that the superposition effects due to multiple beams of light takes place just due to the superposition state vectors without the need of any detectors. Readers may raise the question: are really missing anything? Let us consider Bell's inequality theorem [18]. It refers to superposition (amplitude summation) of two "coherent" phases of light, $\psi = \exp[i\phi_{1,2}]$ and registering the corresponding fringes as per QM prescription $\psi^*\psi$ which is $2[1+\cos(\phi_1 - \phi_2)]$ as if the EM fields by themselves produce fringes without the assistance of the detectors. However, the summation of the superposition effect is carried out by the detector. Each of the two fields has to be physically present on the detector and stimulating it simultaneously. All detectors wear "quantum goggles" or are dictated by the QM rules. Thus χ plays a

profound physical and practical role in what we may observe as superposition effects. In reality, the detector electron counts are:

$$D = {}^{(1)}\chi^2 a^2 \left| e^{i\phi_1} + e^{i\phi_2} \right|^2 = 2\,{}^{(1)}\chi^2 a^2 [1 + \cos(\phi_1 - \phi_2)] \tag{15}$$

The benignly neglected χ in Bell's theorem contains most of the physics of reality. This susceptibility jointly depends upon all the key parameters of the simultaneously present EM fields and those properties of the detector molecules prescribed by QM rules (constraints) – the frequencies of the fields, the QM allowed dipole frequencies of the detector set by the transition rules, explicitly electric and magnetic vectors of the EM fields and the corresponding induced vectors for the detecting molecule embedded in any anisotropic medium, the Poynting vectors of the incident EM fields, etc. Real engineers worry about all these factors when they design some serious system that must not fail. They key point is that Bell's inequality relation does not apply to the measurement of real physical superposition effect due to EM waves, because EM waves by themselves do not interfere.

The premise of Reality Ontology of classical physics, consistently seeking reality in nature, is still the best guiding light for us do advance science.

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